

What is claimed is:

- 1           1.     A method of manufacturing an electromechanical device having a mechanical  
2     structure that is disposed in a sealed chamber which is formed, at least in part, by an  
3     encapsulation layer, the method comprising:  
4           forming at least one anti-stiction channel through the encapsulation layer;  
5           introducing an anti-stiction fluid into the chamber via the anti-stiction channel  
6     wherein the anti-stiction fluid forms a monolayer or self-assembled layer on at least a  
7     portion of the mechanical structure; and  
8           depositing an anti-stiction plug over or in the anti-stiction channel to re-seal the  
9     chamber.
- 1           2.     The method of claim 1 wherein the anti-stiction fluid includes DDMS, OTS,  
2     PFOTCS, PFDA, FDTS, PFPE or FOTS.
- 1           3.     The method of claim 1 wherein the at least one anti-stiction channel is formed  
2     through the encapsulation layer using anisotropic etching.
- 1           4.     The method of claim 3 wherein the at least one anti-stiction channel is formed  
2     through the encapsulation layer using reactive ion etching.
- 1           5.     The method of claim 1 wherein the anti-stiction plug includes spin-on polymer,  
2     SOG or a metal material.

1           6.     The method of claim 1 wherein the anti-stiction plug includes spin-on polymer  
2 or SOG which is deposited using silk screening.

1           7.     The method of claim 1 wherein the anti-stiction plug includes spin-on polymer  
2 or SOG which is deposited using dispensed seal-glass, plastic or epoxy.

1           8.     The method of claim 1 wherein the electromechanical device further includes  
2 a contact area and wherein the method further includes:  
3         forming a trench around the contact area wherein the contact area is at least  
4 partially disposed outside the chamber; and  
5         depositing a first insulating material in the trench to electrically isolate the contact  
6 area.

1           9.     The method of claim 8 further including:  
2         depositing a second insulating layer over at least a portion of the trench; and  
3         depositing a highly conductive material on the contact and over the second  
4 insulating layer to provide electrical connection to the contact area.

1           10.    The method of claim 8 further including:  
2         depositing a second insulating layer over at least a portion of the trench; and  
3         forming an anti-stiction window in the second insulating layer before forming the at  
4 least one anti-stiction channel through the encapsulation layer.

1           11.    The method of claim 10 further including depositing a highly conductive  
2 material on the contact area and over the second insulating layer to provide electrical  
3 connection to the contact area wherein at least a portion of the anti-stiction plug is  
4 comprised of the highly conductive material.

1           12.    The method of claim 10 further including depositing a diffusion barrier on the  
2 anti-stiction plug.

1           13.    The method of claim 12 wherein the diffusion barrier is comprised of a  
2 polysilicon, germanium, silicon/germanium, silicon dioxide, silicon nitride, BPSG, PSG,  
3 SOG or metal bearing material.

1           14.    The method of claim 10 further including depositing a highly conductive  
2 material on the contact area and over the second insulating layer and anti-stiction plug  
3 wherein the highly conductive material provides a barrier to diffusion for the chamber and  
4 electrical interconnection for the contact area.

1           15.    The method of claim 8 wherein the trench is formed simultaneously with the  
2 forming of the at least one anti-stiction channel through the encapsulation layer.

1           16.    A method of manufacturing an electromechanical device having a mechanical  
2 structure which is disposed over a substrate and in a sealed chamber which is formed, at  
3 least in part, by an encapsulation structure, the method comprising:  
4           forming at least one anti-stiction channel through the substrate;

5           introducing an anti-stiction fluid into the chamber via the at least one anti-stiction  
6   channel wherein the anti-stiction fluid forms a monolayer or self-assembled layer on at least  
7   a portion of the mechanical structure; and  
8           depositing an anti-stiction plug over or in the anti-stiction channel to re-seal the  
9   chamber.

1           17.    The method of claim 16 wherein the anti-stiction fluid includes DDMS, OTS,  
2   PFOTCS, PFDA, FDTS, PFPE or FOTS.

1           18.    The method of claim 16 wherein the at least one anti-stiction channel is  
2   formed through the substrate using anisotropic etching.

1           19.    The method of claim 18 wherein the at least one anti-stiction channel is  
2   formed through the encapsulation layer using reactive ion etching.

1           20.    The method of claim 16 further including securing the encapsulation structure  
2   over the mechanical structure using anodic bonding.

1           21.    The method of claim 20 wherein the encapsulation structure includes an  
2   anodic shield.

1           22.    The method of claim 21 wherein the encapsulation structure includes an  
2   insulation layer which is disposed on a cap wafer.

1           23.    The method of claim 21 wherein the anodic shield is disposed on the  
2 insulation layer.

1           24.    The method of claim 16 wherein the anti-stiction plug includes spin-on  
2 polymer, SOG or a metal material.

1           25.    The method of claim 16 wherein the anti-stiction plug includes spin-on  
2 polymer or SOG which is deposited using silk screening.

1           26.    The method of claim 16 wherein the anti-stiction plug includes spin-on  
2 polymer or SOG which is deposited using dispensed seal-glass, plastic and/or epoxy.

1           27.    The method of claim 16 wherein the anti-stiction plug is deposited using  
2 shadow mask technology.

1           28.    The method of claim 16 wherein the electromechanical device further includes  
2 a contact area and wherein the method further includes:  
3           forming a trench in the substrate, around the contact area; and  
4           depositing a first insulating material in the trench to electrically isolate the contact  
5 area.

1           29.    The method of claim 28 further including:  
2           depositing a second insulating layer over at least a portion of the trench; and

3            depositing a highly conductive material on the contact area and over the second  
4            insulating layer to provide electrical connection to the contact area.

1            30.    The method of claim 28 further including:  
2            depositing a second insulating layer over at least a portion of the trench; and  
3            forming an anti-stiction window in the second insulating layer before forming the at  
4            least one anti-stiction channel through the substrate.

1            31.    The method of claim 30 further including depositing a highly conductive  
2            material on the contact area and over the second insulating layer to provide electrical  
3            connection to the contact area wherein the anti-stiction plug is comprised of the highly  
4            conductive material.

1            32.    The method of claim 30 further including depositing a diffusion barrier on the  
2            anti-stiction plug.

1            33.    The method of claim 30 wherein the diffusion barrier is comprised of a  
2            polysilicon, germanium, silicon/germanium, silicon dioxide, silicon nitride, BPSG, PSG,  
3            SOG or metal bearing material.

1            34.    The method of claim 30 wherein the anti-stiction fluid includes DDMS, OTS,  
2            PFOTCS, PFDA, FDTs, PFPE or FOTS.

1           35.    The method of claim 30 further including depositing a highly conductive  
2 material on the contact area and over the second insulating layer and anti-stiction plug  
3 wherein the highly conductive material provides a barrier to diffusion for the chamber and  
4 electrical interconnection to the contact area.

1           36.    An electromechanical device comprising:  
2 a substrate;  
3 a mechanical structure disposed over the substrate wherein a monolayer or self-  
4 assembled layer is disposed on at least a portion of the mechanical structure;  
5 a film encapsulation structure, disposed over the mechanical structure, to define and  
6 seal a chamber;  
7 an anti-stiction channel, etched into the film encapsulation structure, to provide  
8 access to at least a portion of the mechanical structure disposed in the chamber; and  
9 an anti-stiction plug, disposed over or in the anti-stiction channel, to re-seal the  
10 chamber.

1           37.    The device of claim 36 wherein the film encapsulation structure includes first  
2 and second encapsulation layers.

1           38.    The device of claim 37 wherein the first encapsulation layer is comprised of  
2 polycrystalline silicon, porous polycrystalline silicon, amorphous silicon, silicon carbide,  
3 silicon nitride, silicon/germanium, germanium, or gallium arsenide.

1           39.    The device of claim 37 wherein the second encapsulation layer is comprised  
2   of polycrystalline silicon, porous polycrystalline silicon, amorphous silicon, germanium,  
3   silicon/germanium, gallium arsenide, or silicon carbide.

1           40.    The device of claim 36 wherein the anti-stiction plug includes spin-on  
2   polymer, SOG or a metal material.

1           41.    The device of claim 36 wherein the anti-stiction plug includes spin-on polymer  
2   or SOG which is deposited using silk screening.

1           42.    The device of claim 36 wherein the anti-stiction plug includes spin-on polymer  
2   or SOG which is deposited using dispensed seal-glass, plastic and/or epoxy.

1           43.    The device of claim 36 wherein the anti-stiction plug is deposited using a  
2   shadow mask technology.

1           44.    The device of claim 36 further including a trap, disposed between the anti-  
2   stiction channel and the mechanical structure.

1           45.    The device of claim 44 wherein the trap is a substantially vertical trap.

1           46.    The device of claim 44 wherein the trap is a substantially horizontal trap.

1           47.    The device of claim 35 further including a diffusion barrier disposed over the  
2   anti-stiction plug.

1           48.    The device of claim 47 wherein the diffusion barrier is comprised of a metal  
2 material.

1           49.    An electromechanical device comprising:  
2           a substrate;  
3           a mechanical structure disposed over the substrate wherein a monolayer or self-  
4 assembled layer is disposed on at least a portion of the mechanical structure;  
5           a wafer bonded encapsulation structure, disposed over the mechanical structure, to  
6 define and seal a chamber;  
7           an anti-stiction channel, etched into the substrate, to provide access to at least a  
8 portion of the mechanical structure disposed in the chamber; and  
9           an anti-stiction plug, disposed over or in the anti-stiction channel, to re-seal the  
10 chamber.

1           50.    The device of claim 49 wherein the encapsulation structure is secured over  
2 the mechanical structure using anodic bonding.

1           51.    The device of claim 49 wherein the encapsulation structure includes an  
2 anodic shield.

1           52.    The device of claim 49 wherein the encapsulation structure includes an  
2 insulation layer which is disposed on a cap wafer.

1           53.    The device of claim 49 wherein the anodic shield is disposed on the insulation  
2 layer.

1           54.    The device of claim 49 wherein the anti-stiction plug includes spin-on  
2 polymer, SOG or a metal material.

1           55.    The device of claim 49 wherein the anti-stiction plug includes spin-on polymer  
2 or SOG which is deposited using silk screening.

1           56.    The device of claim 49 wherein the anti-stiction plug includes spin-on polymer  
2 or SOG which is deposited using dispensed seal-glass, plastic and/or epoxy.

1           57.    The device of claim 49 wherein the anti-stiction plug is deposited using a  
2 shadow mask technology.

1           58.    The device of claim 49 further including a trap, disposed between the anti-  
2 stiction channel and the mechanical structure.

1           59.    The device of claim 58 wherein the trap is a substantially vertical trap.

1           60.    The device of claim 58 wherein the trap is a substantially horizontal trap.

1           61.    The device of claim 49 further including a diffusion barrier disposed over the  
2 anti-stiction plug.

1            62.    The device of claim 61 wherein the diffusion barrier is comprised of a metal  
2    material.